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PSIM 2025
Elective 5: Modifying for Levels of Inquiry

Content:

Resource Description ([LINK](#)):

The NASA resource “Modeling Additive Velocity with Spreadsheets” can be used to:

- Support student understanding of the relationship between mass, force, acceleration and distance
- Support student use of digital spreadsheets (Google Sheets)
- Introduce students to NASA spacecrafts
- Build student skills in applying content knowledge to real-world scenarios

Students will be asked to read the background information on how spacecrafts are propelled using electric propulsions, the two NASA spacecrafts that use this type of propulsion (Dawn Spacecraft and Psyche Spacecraft) as well as a review of Newton’s Laws. Students then need to choose a spacecraft they want to study and then create a spreadsheet that calculates and graphs the acceleration, distance traveled and change in velocity over time. Students are then given conclusion questions, where they use their spreadsheet to answer them.

Connection To Physics Content:

This activity is directly related to physics content. This activity would be a great culmination/conclusion activity to close out the motion/forces unit, as the data looks at distance, velocity and acceleration. In addition to its connection to the physics content, this activity also supports students in using a digital spreadsheet to organize, visualize and analyze the data. Part of the physics curriculum is to teach students how to think like a scientist, including collecting and analyzing data, which this activity directly works on.

Discovery Learning:

This activity can be used for discovery learning due to the activity being built around the students manipulating and analyzing data on their own. The students are given a real-world problem (how a spacecraft’s velocity changes based on thrust) and need to apply their prior knowledge about velocity and acceleration to come to a conclusion. Students are “hands on” manipulating the spreadsheet to collect the necessary data, and then graphing the data to come to a conclusion. Through this activity, students are using the data and spreadsheet to determine the relationship between additive velocity and changing velocity/acceleration.

Pros/Cons of Resource:

Pros - there are many pros to this resource. The first pro is this activity asks students to apply the knowledge they already know (velocity and mass) to something new (ion engine thrust). Students are used to only being asked to regurgitate information that is fed to them in class. This activity forces students to apply that information to a new concept and be able to explain it, even if they have not been explicitly taught it. Another pro of this activity is that it teaches students how to use Google Sheets/Excel. Being able to use and manipulate a spreadsheet is an important skill for students entering into the job market, no matter what field they are

entering. There may not be a lot of time spent in school learning and practicing how to use a spreadsheet, as this does not directly align with any particular content area. This activity is a great opportunity for students to learn and practice their spreadsheet skills, both performing calculations and creating graphs. Another pro for this activity is that students are asked to use the spreadsheet to analyze the data. Creating graphs is a way to visualize data, and then students need to use the data and the graphs to be able to draw conclusions. This is directly related to physics content as well as expected student outcomes in physics. The final pro for this assignment is how well it lends itself to both group and individual work. Students can work together to work on their spreadsheets, calculations and graphs, and collaborate on drawing their conclusions. However, this assignment could also be great for those students who prefer to work alone/need to complete the assignment at home for homework. As long as they have support in learning how to navigate and manipulate the spreadsheet, this assignment could be done largely at home, independently if needed.

Cons - Although there are many pros for this activity, there are also a few cons. The first con is the amount of time and effort it may take from the teacher to explicitly teach students how to use the spreadsheet. If students are unfamiliar with Google Sheets/Excel, teachers will need to spend a chunk of time getting students familiar with the program, and teaching them the basics. This can make the activity feel like it is focused more on the skill of using a spreadsheet, rather than physics. Another con is that students may not be used to applying knowledge to real world scenarios. A lot of students are used to just memorizing material for tests and never actually use what they learn to problem solve. Students may get caught up in what electric propulsion systems are, and not be able to move forward with the work. Teachers need to ensure they frame the lesson that the electric propulsion system is an example of how we can understand motion (velocity and acceleration), and that the lesson is not about learning and understanding what electric propulsion systems are.

Modifications for Levels of Inquiry:

Low Level of Inquiry (Structured/Guided Discovery):

This activity can be modified to have a low level of inquiry. This can be done through providing a detailed spreadsheet that was identical for every student, which contained some of the cells filled out and had step by step, explicit instructions for the students to follow. This structure would help get kids to the finish line, and answer specific questions relating to the data and how the teacher wants the data to be analyzed. These questions would come in the form of a conclusion worksheet, similar to the one that is provided in this activity. The way the original activity is set up would be low level of inquiry, as the research question, instructions and conclusion worksheet are structured and provided for the students. In order to be an even lower level, providing the example cells in the spreadsheet would allow students to just copy and paste the equation into the next cell, or drag the equation, without necessarily understanding the math that is being completed.

High Level of Inquiry (Student-Designed Investigation):

This activity can also be modified to have a high level of inquiry. In order to do this, students would be given a broad prompt (ex. Explore the motion of spacecrafts through electric

propulsion). Students would be given a higher level background article about the NASA spacecrafts (Psyche and Dawn) and their use of electric propulsion systems. Students would then be provided initial data for each spacecraft (initial velocity, total mass and ion engine thrust). Students would then be asked to create a research question relating to the prompt given, using the data and background knowledge from the article (ex. What happens to the acceleration of the spacecraft when the mass is doubled?). Teachers can recommend that students use a spreadsheet in order to collect their data, but how the students collect their data is entirely up to them. Once their question is formed, students work to use the initial values they are given to collect data in order to answer the question they are asking. Students would be tasked with completing a lab write up, which has all of the necessary components of a research paper: introduction/background (info from article), methods (students come up with this on their own), results (demonstrated in a visual way, like a graph), discussion and conclusion. Students could choose to write this as a paper, or demonstrate this information in a presentation. These modifications would be considered a high level of inquiry because the students are using the background knowledge and initial data to come up with their own question. All of the groups would be testing something different, while starting with the same data. Students then would analyze and discuss their own data and draw conclusions relating back to their own hypothesis. Students would be clearly driving the lesson, and the teacher would take the role of the coach, rather than explicitly teaching the content.